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(71)Applicant : FUJI PHOTO FILM CO LTD

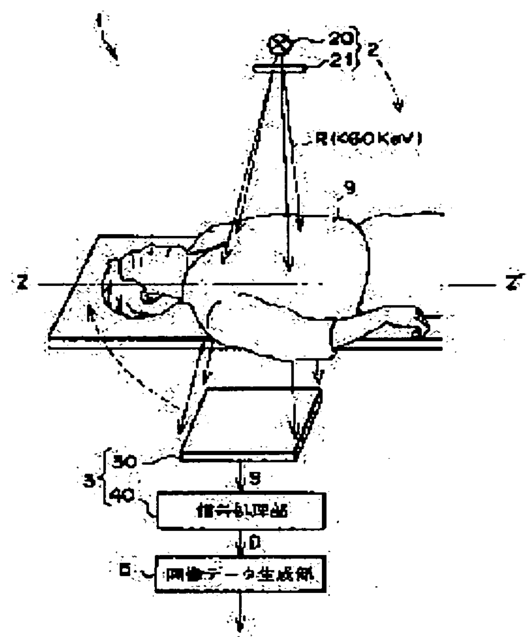
(72)Inventor : ARAKAWA SATORU

(54) RADIATION IMAGE SIGNAL DETECTOR

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a sectional image and a three-dimensional image not influenced with a scatterd radiation in a cone beam CT device.

SOLUTION: Only a relatively high energy level of a radiation (over 60 KeV) is radiated to an object 9 through a copper sheet filter 21. The radiation which penetrates the object 9 is detected with a quantum counting-type radiation detector 3 with an energy discriminating function. A detecting part 30 of the detector 3 generates voltage which corresponds to an energy level of a radiation particle. A signal processing part 40 calculates the number of the radiation particles and has an energy level over 60 KeV which is transmitted in the detecting part 30 in a fixed time, then a result of the calculation is used as a pixel data. The energy level of a primary radiation which goes almost straight on the object 9 is higher than that of scatterd radiation which is dispersed from the object 9 and energy discrimination is conducted by setting 60 KeV as a threshold, then an image data is formed based on only a primary radiation component thereby influence of scattered radiation can be decreased.



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(71)出願人 000005201
富士写真フイルム株式会社
神奈川県南足柄市中沼210番地

(72)発明者 荒川 哲
神奈川県足柄上郡開成町宮台798番地 富士写真フイルム株式会社内

(74)代理人 100073184
弁理士 柳田 征史 （外1名）

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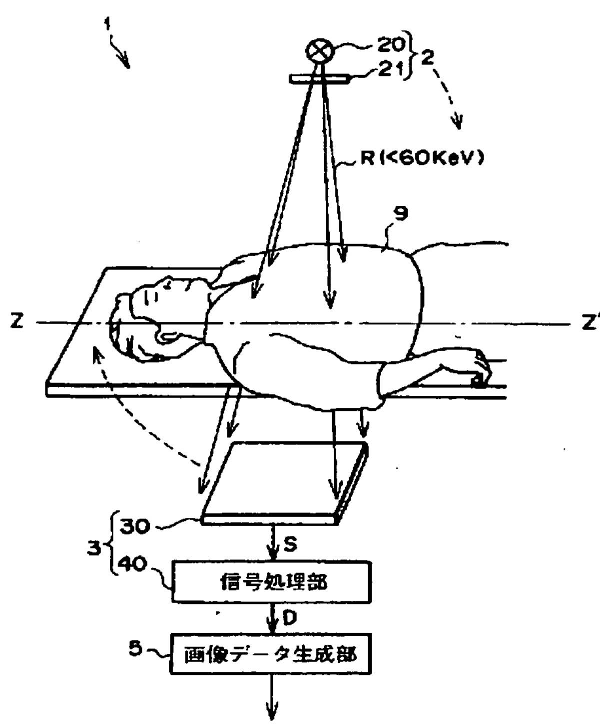
(54)【発明の名称】 放射線画像信号検出装置

(57)【要約】

【課題】 コーンビームCT装置において、散乱線の影響を受けない断層画像や3次元画像が得られるようにする。

【解決手段】 銅板フィルタ21を介して比較的高いエネルギーレベルの放射線（60KeV以上）のみを被写体9に照射する。被写体9を透過した放射線を、エネルギー弁別機能を有する量子計数型の放射線検出器3で検出する。検出器3の検出部30は、放射線粒子のエネルギーレベルに応じた電圧を発生する。信号処理部40は、一定時間内に検出部30に入射したエネルギーレベルが60KeV以上の放射線粒子数を計数し、計数結果を画素データとする。被写体9を略直進する1次放射線のエネルギーレベルは、被写体9内で散乱した散乱線のエネルギーレベルよりも高く、60KeVを閾値としてエネルギー弁別し、1次放射線成分のみに基づいて画像データを生成することにより散乱線の影響を低減する。



DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] this invention relates to the improvement of quality-of-image degradation by the scattered radiation in more detail about the radiation picture signal detection equipment which acquires a photographic subject's radiation picture signal by detecting the radiation which penetrated the photographic subject by the radiation detector.
[0002]
[Description of the Prior Art] Conventionally, in the field of a medical picture, X-ray CT, MRI, etc. are proposed as equipment which acquires a photographic subject's gestalt-two-dimensional information (fault picture).
[0003] "X-ray CT" allots the radiation source which emits radiation, such as an X-ray, to a photographic subject's one side. A line sensor (radiation solid state detector of a single dimension) is allotted to a photographic subject's another side. The radiation emitted from the radiation source is formed into a fan beam using a slit for scattered-radiation removal. A photographic subject's transparency radiation picture signal is acquired by detecting the radiation which penetrated the photographic subject while rotating the radiation source and the line sensor relatively surroundings / of this photographic subject] centering on the virtual shaft (henceforth a "body axis") on both sides of the photographic subject by the line sensor. A photographic subject's fault picture is acquired based on the transparency radiation image information (1-dimensional image information) of a large number acquired in each rotation position, i.e., each projection direction.
[0004] "MRI" acquires a fault picture using nuclear magnetic resonance by the same method as the above-mentioned X-ray CT and abbreviation.

[0005] Moreover, the technical research which detects a photographic subject's gestalt 3-dimensional information (stereoscopic model) has accomplished, for example, helical CT and the cone beam CT are proposed by the end of today (present condition [of cone beam CT development], and "future" image (information M);1988 year 1 month P122 - P127 reference).
[0006] "Helical CT" is one of the multi-stage layer X-ray CT technique. The "multi-stage layer X-ray CT technique" is matched for a photographic subject's one side with the radiation source which emits radiation here. Allot a line sensor to a photographic subject's another side, and the radiation emitted from the radiation source is formed into a fan beam by the slit like X-ray CT. A photographic subject's transparency radiation picture signal is acquired by detecting the radiation which penetrated the photographic subject while rotating the body axis for the radiation source and the line sensor relatively as a center around this photographic subject on both sides of the photographic subject by the line sensor. A photographic subject's fault image data is computed based on the transparency radiation image information (1-dimensional image information) of a large number acquired in each rotation position, i.e., each projection direction, (it is the operation same so far as the above-mentioned X-ray CT). After moving the radiation source and a line sensor in the direction of a body axis, fault image data is again computed like ****. Interpolation calculation of the image data of the direction of a body axis is carried out from the fault image data in much move positions of this body-axis direction, and it asks for the aforementioned photographic subject's volume data (3-dimensional radiation image information).
[0007] It faces in quest of the fault image data which continued in the above-mentioned body-axis direction here, and especially the thing to which it is made to move in the shape of [which makes the radiation source and a line sensor the medial axis of rotation of a photographic subject's body axis] a vine firewood spiral is called "helical CT (spiral CT)."
[0008] In addition, in this helical CT, the helical (scan) CT technique using the area sensor (two-dimensional radiation solid state detector) and the cone beam (conical beam) is also proposed ("3-dimensional helical scan CT using circular-cone beam projection" electronic-intelligence communication society paper magazine D-II vol.J74-D-II No.8 1991 August). Hereafter, in order to distinguish the helical CT by this technique, and the helical CT of the method using the above-mentioned line sensor, the helical CT of a method which uses a line sensor is called "usual helical CT."
[0009] Moreover, "the cone beam CT" is matched for a photographic subject's one side with the radiation source which emits cone-like radiation. A photographic subject's transparency radiation picture signal is acquired by detecting the radiation which penetrated the photographic subject while allotting an area sensor to a photographic subject's another side and rotating the radiation source and the area sensor relatively surroundings / of this photographic subject] on both sides of the photographic subject by the aforementioned area sensor. Based on two or more transparency radiation image information acquired in each rotation position, i.e., each projection direction, volume data and the fault image data about a photographic subject are acquired.
[0010]
[Problem(s) to be Solved by the Invention] By the way, if radiation is irradiated at a photographic subject, a part of radiation will be scattered about in a photographic subject's each part, and it will serve as scattered radiation. Therefore, in the radiation which penetrated the photographic subject, it will be emitted from a line source and the component of this scattered radiation other than primary radiation components which go straight on and penetrate the inside of a photographic subject will be contained.
[0011] The radiation emitted from the radiation source as mentioned above in CT of the method in here using a line sensor as a radiation detector like X-ray CT or the usual helical CT is formed into a fan beam by the slit, it is rare to detect the component of the scattered radiation, since it is the method which detects only the radiation which penetrates a photographic subject and carries out rectilinear-propagation incidence by the line sensor, and the influence of this scattered radiation is comparatively small.
[0012] On the other hand, in order that radiation may carry out incidence to the whole photographic subject by cone-like radiation irradiation in the helical CT and the cone beam CT using the above-mentioned cone beam, the scattered radiation occurs mostly, and this scattered radiation penetrates a photographic subject and carries out incidence to an area sensor. Therefore, in order that an area sensor may detect many scattered radiation scattered about in not only the primary radiation that a photographic subject irradiates, and goes straight on and penetrates the inside of this photographic subject but a photographic subject's each part, the signal component by this scattered radiation mixed in the original picture signal (component by primary radiation), and the problem that contrast falls or the picture in which picture quality -- sufficient S/N is not obtained -- deteriorated is outputted has arisen.
[0013] this invention is made in view of the above-mentioned situation, and it aims at offering the radiation picture signal detection equipment which can improve the problem of quality-of-image degradation by the scattered radiation.
[0014]

[Means for Solving the Problem] As mentio[illegible]bove, when radiation is irradiated at a photographic su[illegible] a part of radiation will be scattered about in a photographic subject's each par[illegible] serve as scattered radiation, and the component of t[illegible]attered radiation other than primary radiation components which go straight on and penetrate the inside of a photographic subject will be contained in the radiation which penetrated the photographic subject.
[0015] Here, it faces that radiation penetrates a photographic subject and the energy level of the transparency radiation which penetrated the photographic subject falls somewhat rather than the time of the incidence to a photographic subject (before transparency) by the absorption of radiation by the bone or the living body component of built-in. However, it compares with primary radiation and the energy level of the scattered radiation is a low more.
[0016] this invention is made paying attention to the difference of the energy level of this primary radiation and the scattered radiation, by energy discrimination, distinguishes primary radiation and the scattered radiation sharply and acquires a radiation picture signal only based on primary radiation.
[0017] Namely, the 1st radiation picture signal detection equipment by this invention Allot the radiation source which emits radiation to a photographic subject's one side, and a radiation detector is allotted to a photographic subject's another side. The detecting element to which it is radiation picture signal detection equipment which acquires a photographic subject's radiation picture signal by detecting the radiation which penetrated the photographic subject by the radiation detector, and a radiation detector outputs the signal of the level according to the energy level of radiation, It is characterized by being what consists of the signal-processing section which acquires a radiation picture signal based on the signal which excepted the signal by the energy component of only the signal by the energy component more than a specific threshold, i.e., below the aforementioned threshold, among the signals outputted from this detecting element.
[0018] The 2nd radiation picture signal detection equipment by this invention Allot the radiation source which emits cone-like radiation to a photographic subject's one side, and a radiation detector is allotted to a photographic subject's another side. It is radiation picture signal detection equipment which acquires a photographic subject's radiation picture signal by detecting the radiation which penetrated the photographic subject while rotating the radiation source and the radiation detector relatively [surroundings / of this photographic subject] on both sides of the photographic subject by the radiation detector. The detecting element to which a radiation detector outputs the signal of the level according to the energy level of radiation, It is characterized by being what consists of the signal-processing section which acquires a radiation picture signal based on the signal which excepted the signal by the energy component of only the signal by the energy component more than a specific threshold, i.e., below the aforementioned threshold, among the signals outputted from this detecting element.
[0019] It faces carrying out "rotating the radiation source and a radiation detector relatively [surroundings / of this photographic subject] on both sides of a photographic subject", and the signal-processing section of a detector may not necessarily be rotated that what is necessary is just what rotates the aforementioned detecting element and the radiation source relatively / surroundings / of this photographic subject] on both sides of a photographic subject at least.
[0020] It is desirable for "a specific threshold" to mean a suitable value to discriminate between the component [component] of comparatively high energy comparatively (for it not to be necessary to be perfect discrimination) in the above, and to consider as primary radiation components which carry out incidence of the component of comparatively high especially energy to a photographic subject, and carry out abbreviation rectilinear propagation, to use the component of low energy as the scattered-radiation component scattered about with a photographic subject comparatively, and to consider as a suitable value to distinguish these both Moreover, as for this "specific threshold", it is desirable to set in consideration of many requirements for the inside-and-outside section organ of human beings, such as the radiation source, a photographic subject's age, and sex.
[0021] In addition, if it is the solid state detector which is equipped with the above-mentioned detecting element and the signal-processing section, and becomes considering a semiconductor with the energy discrimination function as the principal part as a radiation detector used in the above 1st and the 2nd radiation picture signal detection equipment, what thing may be used and the configuration will not be asked, either. In addition, as this radiation detector, it is suitable to use a quantum digital detector.
[0022] An "energy discrimination function" means distinguishing sharply comparatively the radiation which carried out incidence to the detector for the component of low energy, and the component of comparatively high energy based on the difference of the energy level of radiation.
[0023] With a "quantum digital detector", the sensor (detection crystal) which outputs the signal of the level according to the energy level of a radiation photon (particle) as the aforementioned detecting element is used. Carry out threshold comparison of the voltage pulse outputted from this sensor when one radiation photon carries out incidence to a sensor with a comparator, and energy discrimination is carried out. The number of fixed hour meters is performed for the digital pulse acquired by this by the counter. Counting of the number of radiation photons which carried out incidence is carried out to a sensor at this fixed time. It is what inputs a result into the aforementioned signal-processing section, and acquires a radiation picture signal. this -- counting -- It is (refer to "INNERVISION(10-7)1995" ;P 47-48, "medical electron, bionics, and 32nd volume special number (1994)" ;P311 and Shimazu criticism VOL.49, and No3 (1992. 10) ;P185 - 189 grade).
[0024] In addition, it is desirable to use the area sensor which detects radiation two-dimensional especially as a radiation detector used in the radiation picture signal detection equipment of the above 2nd. Moreover, use a line sensor, and arrange a majority of these line sensors, or it is made to move, and you may make it acquire a two-dimensional radiation picture signal by compounding those outputs.
[0025] That moreover, it is in the radiation picture signal detection equipment of the above 2nd with the radiation source which emits cone-like radiation what is limited to what is used in the conventional cone beam CT using the punctiform radiation source -- not but The scanned type radiation source which reference"SPIE VOL.2708P140 - P149" and these people used in the equipment proposed by Japanese Patent Application No. No. 238737 [ten to], That is, you may be the radiation source of the method which has the line source of a large number arranged on a field, and irradiates radiation to each of this line source with a change one by one at a photographic subject. And it is desirable to consider as the detector which detects the radiation which has the detection field of an area smaller than the area of the field where the line source of a large number in this radiation source has been arranged as a radiation detector used in this case, was emitted by the scan from each line source, and penetrated the photographic subject one by one. This detector may consist of one detection sensor, and may consist of two or more detection sensors.
[0026] Furthermore, it is desirable to have had an irradiation energy-control means to irradiate only the radiation of the energy level more than the aforementioned threshold to the radiation source of the above 1st by this invention and the 2nd radiation picture signal detection equipment at a photographic subject.
[0027] When radiation is emitted, even if it includes the radiation of the energy level below a threshold that what is necessary is just that in which only the radiation of the energy level more than the aforementioned threshold is made to carry out incidence to a photographic subject as this irradiation energy-control means, by the time it arranges filters, such as a copper plate, among photographic subjects a generating agency, for example and radiation carries out incidence to a photographic subject, you may remove the radiation of the energy level below the aforementioned threshold. In this case, filters, such as a copper plate, are equivalent to an irradiation energy-control means.
[0028] In addition, it cannot be overemphasized that it is most desirable that it is the thing which is called monochrome radiation source and which emits the radiation of a single energy level as the radiation source. In this case, a means by which the radiation of a single energy level is emitted is equivalent to an irradiation energy-control means.
[0029]
[Effect of the Invention] The detecting element which is made paying attention to the difference of the energy level of primary radiation and the scattered radiation, and outputs the signal of the level according to the energy level of radiation as the radiation picture signal detection

equipment by this invention was mentione[illegible]e, The radiation detector which consists of the signal-[illegible]ssing section which acquires a radiation picture signal among the signals [illegible]ted from this detecting element only based on the sig[illegible]the energy component more than a specific threshold is used. A suitable value to discriminate from primary radiation components and a scattered-radiation component as "a specific threshold" is used. Since it is made to acquire a picture signal only based on the signal by the energy component more than this threshold without the component containing many scattered radiation below this threshold as a picture signal It comes to be outputted as a result which detected more components by primary radiation as a radiation picture signal outputted from the signal-processing section, and the influence of the scattered radiation can be reduced. Therefore, if a fault picture and a 3-dimensional picture are formed based on this picture signal, the picture of high S/N and quantity contrast with sufficient picture quality can be acquired.
[0030] Since the influence of the scattered radiation can reduce with the CT equipment of a method especially using a cone beam and an area sensor, without performing slit photography if the radiation picture signal detection equipment by this invention is applied to CT equipment of this method although it is difficult to perform slit photography for scattered-radiation removal, the effect which this invention achieves to CT equipment of this method is very large.
[0031] Moreover, if a quantum digital detector is used as a radiation detector, it can discriminate from the energy level of a radiation photon in photon each, and it will become possible to distinguish primary radiation and the scattered radiation sharply with a sufficient precision. Moreover, a more nearly quality radiation picture signal can be acquired using the property of the outstanding property which a quantum digital detector has, i.e., high sensitivity, and an extensive dynamic range.
[0032] Moreover, it considers as the radiation source equipped with an irradiation energy-control means to irradiate only the radiation of the energy level more than a threshold at a photographic subject, and if the radiation below the aforementioned threshold is removed beforehand and a photographic subject is irradiated, since the radiation below the aforementioned threshold is considered that many components of the scattered radiation are included, it will become possible [discriminating with a sufficient precision from the scattered radiation and primary radiation] among the radiation which penetrated the photographic subject. [at least] Moreover, it will consider that all the transparency radiation of the same energy as the energy of the radiation emitted from the radiation source is primary radiation, it can be detected, and the radiation emitted from the radiation source can be used without futility. Furthermore, as a secondary effect, since the radiation below the threshold which does not contribute to generation of a radiation picture signal is not irradiated at a photographic subject, contamination mitigation to a photographic subject can also be aimed at.
[0033]
[Embodiments of the Invention] Hereafter, with reference to a drawing, the gestalt of 1 operation of the radiation picture signal detection equipment by this invention is explained in detail.
[0034] The outline block diagram of the cone beam CT equipment 1 with which drawing 1 applied the radiation picture signal detection equipment by the gestalt of operation of this invention, the block diagram (A) showing the detail for 1 pixel of the radiation detector 3 which uses drawing 2 for this CT equipment 1 and a wave form chart (B), and drawing 3 are the energy-spectrum views of the radiation emitted from the radiation source 2.
[0035] The radiation source 2 to which the CT equipment 1 concerned emits the cone-like radiation R towards a photographic subject 9 as shown in drawing 1 , A photographic subject 9 It inserts and the aforementioned radiation source 2 is matched for the position which counters. a photographic subject 9 The transmitted radiation The detecting element 30 to detect Based on transparency radiation image data D outputted from the radiation detector 3 and radiation detector 3 which consist of the signal-processing section 40 which asks for transparency radiation image data D based on the signal S outputted from this detecting element 30, and volume data and the fault image data about a photographic subject It consists of the image data generation sections 5 to generate.
[0036] Moreover, it has a rotation means by which it does not illustrate [which rotates relatively / surroundings / of this photographic subject 9] the detecting element 30 of the radiation source 2 and a radiation detector 3 on both sides of a photographic subject 9 /. Maintaining the aforementioned physical relationship of the radiation source 2 and the detecting element 30 to a photographic subject 9 as this rotation means, the axis of rotation is set as the body axis shown by Z-Zin drawing' which passes along a photographic subject 9, the radiation source 2 and a detecting element 30 may be rotated, the radiation source 2 and a detecting element 30 are fixed, and a photographic subject 9 may be rotated by setting the axis of rotation as the body axis shown by Z-Zin drawing'.
[0037] The radiation source 2 consists of the generating section 20 and the filter 21 which emit the X-ray as radiation. The line source of 140kV of tube voltage is used for the generating section 20. A copper plate with a thickness of 5mm is used as a filter 21. After passing this copper plate filter 21 for the radiation emitted from the generating section 20, a photographic subject 9 is irradiated. After passing the copper plate filter 21, the component of 60 or less KeV of abbreviation to which the energy level of the radiation particle which carries out incidence to a photographic subject 9 sets a peak to abbreviation 110KeV within the limits of 140 or less KeV of 60 or more KeVs abbreviation of abbreviation as shown in drawing 3 was removed. Only the radiation of a comparatively high energy level which sets a threshold to abbreviation 60KeV by this is irradiated by the photographic subject 9.
[0038] In addition, the inside of the radiation which the thickness of this filter 21 is emitted from the generating section 20, penetrates a photographic subject 9, and carries out incidence to a detector 3, It is desirable to consider as a convenient value to distinguish the energy level of the primary radiation which carries out abbreviation rectilinear propagation of the inside of the energy level of the scattered radiation generated within a photographic subject 9 and a photographic subject 9. It is desirable to consider as the suitable thickness for energy discrimination of primary radiation and the scattered radiation in consideration of many requirements, such as peak value of the energy level of the radiation irradiated by the photographic subject 9, the energy-absorption property of the primary radiation by the photographic subject component, and generating condition of the scattered radiation.
[0039] A radiation detector 3 is a quantum digital detector equipped with the signal-processing section 40 which asks for transparency radiation image data D based on the signal S outputted from this detecting element 30 while being equipped with the detecting element 30 which detects the radiation which penetrated the photographic subject 9 in the shape of two-dimensional (references, such as above-mentioned "medical use electron, bionics, and 32nd volume special number (1994)"). Hereafter, with reference to the detail drawing for 1 pixel shown in drawing 2 , the composition of a detecting element 30 and the signal-processing section 40 is explained.
[0040] A detecting element 30 is equipped with the sensor (detection crystal) 31 which outputs the signal of the level according to each energy level of the radiation particle of the radiation R which penetrated the photographic subject 9, and the amplifier 32 which amplifies the output signal of a sensor 31 and is inputted into the signal-processing section 40.
[0041] You may use what thing, as long as it generates the signal according to the radiation particle energy which carried out incidence as a sensor 31. In this example, what makes the principal part the CdTe (KADONIUMU telluride) crystal which generates the amount of charges according to radiation particle energy is used.
[0042] Amplifier 32 outputs the voltage pulse signal according to the amount of charges generated by this sensor 31. Signal level is made to amplify in the latter signal-processing section 40 to the level which can be used in that case.
[0043] The signal-processing section 4 is equipped with a comparator 41 and a counter 42. A comparator 41 compares voltage pulse signal S inputted from the detecting element 30 by making reference voltage Vth into a threshold. As reference voltage Vth, so that a dispersion line component and primary radiation components can be distinguished sharply It doubles with the radiation which the above-mentioned component of 60 or less KeVs is removed, and carries out incidence to a photographic subject 9. When the radiation particle of this 60KeV less or equal carries out incidence to a sensor 31, the output of a comparator 41 is set to L (low). When a radiation particle with an energy level higher than it

carries out incidence to a sensor 31, it is s[illegible]e value from which the output of a comparator 41 is [illegible]H (highness) (see the wave form chart shown in drawing 2 (B)). Thereby, en[illegible]iscrimination of the radiation component of 60 or more[illegible]s and the radiation component not more than it can be carried out.

[0044] A counter 42 counts the number of times from which the output of a comparator 41 is set to H within fixed time. Thereby, the number of the radiation particles of 60 or more KeVs counts [an energy level] within unit time among the radiation which carried out incidence to the sensor 31.

[0045] That is, in the radiation detector 3 equipped with the detecting element 30 and the signal-processing section 40 which were mentioned above, voltage pulse signal S is generated by one radiation particle which carried out incidence to the sensor 31, and it is judged for the voltage pulse signal S with a comparator 41 by it whether it is more than the reference voltage Vth. If voltage pulse signal S outputted from amplifier 32 is more than the reference voltage Vth, the counted value of the latter counter 42 will count up. That is, counting of every one radiation particle which has the energy more than the fixed level (it is the energy level of the radiation corresponding to reference voltage Vth, and they are 60KeV(s) at this example) which carried out incidence in a sensor 31 is carried out at a certain fixed time, and this counted value D is inputted into the image data generation section 5.

[0046] in addition -- the detail of the method of acquiring a radiation picture by catching every one radiation particle by the sensor 31, and carrying out counting of the number as mentioned above -- the above -- "a medical electron and bionics" -- the 32nd volume [;P] 1995 311 and "INNERVISION" (10-7) -- it is stated to the P47-P48 grade in detail

[0047] The image data generation section 5 generates transparency radiation image data D for the counted value inputted from the counter 42 as a data value of 1 pixel. That is, since the detecting element 30 of a radiation detector 3 detects radiation two-dimensional, it scans electrically each sensor 31 which switches each sensor 31 which constitutes this detecting element 30 one by one, that is, constitutes a detecting element 30, and generates a photographic subject's 9 transparency radiation image data D based on the counted value based on voltage pulse signal S outputted from each sensor 31.

[0048] As mentioned above, since it is the result of the counted value inputted from a counter 42 considering the radiation particle beyond energy-level 60KeV as a count, an energy level is based only on the radiation particle of 60 or more KeVs also as transparency radiation image data D obtained.

[0049] This image data generation section 5 performs various signal processing, such as gamma amendment and picture distorted amendment, further to transparency radiation image data D, generates a photographic subject's 9 projection image data, uses the projection image data of many projection directions (it corresponds to a rotation position), and generates a photographic subject's volume data and fault image data.

[0050] In addition, as an algorithm of volume data generation, the calculation methods which reconfigurate well-known 3-dimensional data, such as a FERUDO comp algorithm (Feldkamp LA, Davis LC, Kress JW, Practical cone-beam algoritm.J Opt Soc Am A 1984;1-612-P619) and a filter amendment back projection method (image-analysis handbook (University of Tokyo Press) p356 - p371 reference), can be used. Here, the detailed explanation about how to ask for this volume data D4 is omitted.

[0051] Hereafter, an operation of the above-mentioned cone beam CT equipment 1 which applied the radiation picture signal detection equipment by this invention is explained.

[0052] Radiation is emitted from the generating section 20 of the radiation source 2, the copper plate filter 21 is passed, the component not more than energy-level 60KeV is removed, and the radiation R beyond energy-level 60KeV is irradiated at a photographic subject 9.

[0053] Each sensor 31 which constitutes the detecting element 30 of a radiation detector 3 inputs into the signal-processing section 40 voltage pulse signal S according to the energy level of a radiation particle which detected and acquired the radiation which penetrated the photographic subject 9 and which makes this radiation.

[0054] Voltage pulse signal S by one radiation particle which carried out incidence to the sensor 31 judges whether it is more than the reference voltage Vth corresponding to energy-level 60KeV, and the comparator 41 of the signal-processing section 40 sets the output to H at the time more than reference voltage Vth. The latter counter 42 counts up counted value, when the output of a comparator 41 is set to H. Counting of every one radiation particle with the energy more than the fixed level (this example 60 KeV(s)) which carried out fixed time continuation of this, and carried out incidence at this fixed time at the sensor 31 is carried out, and this counted value D is inputted into the image data generation section 5.

[0055] The image data generation section 5 makes every [that is,] sensor 31 inputted from the counter 42, and counted value for every pixel the data value of the pixel, respectively, and generates transparency radiation image data D based on this data value (counted value).

[0056] Here, since it was the result of the counted value inputted into the image data generation section 5 considering the radiation particle beyond energy-level 60KeV as a count in a counter 42, the energy level was generated only based on the radiation particle of 60 or more KeVs also as transparency radiation image data obtained.

[0057] Moreover, since the energy level of the dispersion line produced within a photographic subject 9 is more lower than the energy level of the primary radiation which goes straight on and penetrates the inside of a photographic subject 9, it contains many dispersion lines in the comparatively higher one of an energy level in the comparatively lower one of an energy level, including primary radiation mostly. Moreover, since only the radiation (the peak of an energy level is abbreviation 110KeV) of 60 or more KeVs with a comparatively high energy level is irradiated by the photographic subject 9 as mentioned above Many dispersion lines are contained in 60 or less KeVs of the comparatively low energy level which is not contained in the radiation which carries out incidence to a photographic subject among the penetrated radiation which carries out incidence to a photographic subject. primary radiation contains in 60 or more KeVs mostly -- having -- this -- by making 60KeV(s) into a threshold, if energy discrimination is carried out, a dispersion line and primary radiation can think that it is discriminated with a sufficient precision that is, if energy discrimination is performed by making energy-level 60KeV into a threshold, as a signal outputted from a counter 42 and the image data generation section 5 It means detecting the radiation of 60 or more KeVs in which many primary radiation is included, and as a result, it can obtain as that by which the component by the dispersion line was reduced as image data of each pixel, and the transparency radiation image data by which the influence of a dispersion line was reduced can be obtained.

[0058] Moreover, since a quantum digital detector is used as a radiation detector and it discriminates from the energy level of radiation particle each, primary radiation and the scattered radiation are distinguishable with a sufficient precision. Moreover, the outstanding property which a quantum digital detector called high sensitivity and an extensive dynamic range has can be enjoyed, and more nearly quality image data can also be obtained.

[0059] Thus, when the radiation source 2 and the transparency radiation image data in the predetermined rotation position to the photographic subject 9 of a radiation detector 3 (in detail the detecting element 30) are called for Only a predetermined angle rotates relatively the detecting element 30 of the radiation source 2 (making the generating section 20 and a filter 21 into one), and a radiation detector 3 around a photographic subject 9 focusing on body-axis Z-Z', and it asks for the transparency radiation image data in the rotation position, i.e., the projection direction, like ****. Such processing is repeated until the transparency radiation image data for every projection direction covering a photographic subject's 9 perimeter is called for.

[0060] Various signal processing, such as gamma amendment and picture distorted amendment, is performed to the transparency radiation image data for every projection direction, a photographic subject's 9 projection image data is generated, and the image data generation section 5 uses the projection image data of many projection directions, and generates a photographic subject's 9 volume data and fault image data.

[0061] As mentioned above, since the influence of the scattered radiation is reduced, transparency radiation image data can acquire the picture of high S/N and quantity contrast with picture quality sufficient [volume data or fault image data] as a picture based on [the influence of the

scattered radiation is reduced and] these v[illegible]e data or fault image data.
[0062] In the gestalt of the above-mentione[illegible]lementation, although the photographic subject is mad[illegible]y for the radiation of comparatively high energy to be irradiated as the radiation source, this invention is not necessarily limited to this and may have a certain amount of width of face to comparatively high energy from low energy comparatively as an energy level of the radiation irradiated by the photographic subject. The radiation of the energy level judged lower than a threshold to be the scattered radiation is because it only becomes the invalid radiation which is not used as image data though a photographic subject irradiates from the metaphor radiation source. That is, according to this invention, the radiation detector which has an energy discrimination function is used. It is considered that many primary radiation is included in a comparatively high energy component among the radiation which penetrated the photographic subject, and many scattered radiation is comparatively contained in a low energy component. Since it is made to distinguish sharply the primary radiation which carries out abbreviation rectilinear propagation with the scattered radiation produced within a photographic subject (energy discrimination), although the difference in an energy discrimination performance produces the distribution of the energy level of radiation which carries out incidence to a photographic subject, an essential problem does not become.
[0063] From such a viewpoint, with the gestalt of the above-mentioned implementation, a filter 21 is used so that the unnecessary radiation which does not contribute to generation of radiation image data may not be irradiated at a photographic subject. In addition, by irradiating only the radiation of the comparatively high energy level which contributes to generating radiation image data at a photographic subject, the radiation emitted from the radiation source can be used without futility, and, of course, it is efficient.
[0064] Moreover, although what used the radiation detector of the quantum meter number form which can carry out counting of the energy level of a radiation particle to particle each as a radiation detector in the gestalt of the above-mentioned implementation was explained As long as this invention is not limited to this and can carry out energy discrimination of the scattered radiation of a low energy level, and the primary radiation of a comparatively high energy level comparatively, it may use what thing. For example, what distinguishes both sharply based on the difference of the average energy level of the scattered radiation and primary radiation can also be used.
[0065] Furthermore, although the form of above-mentioned operation applies the radiation picture signal detection equipment by this invention to the cone beam CT, this invention is not limited to this. That is, as long as it is equipment which detects radiation by the radiation detector and acquires a radiation picture signal, it may be what thing, and the radiation detector which has an energy discrimination function as a radiation detector can be used, and the radiation picture signal detection equipment by this invention which distinguishes sharply the primary radiation which carries out abbreviation rectilinear propagation with the dispersion line produced within a photographic subject can be applied.
[0066] Moreover, as a radiation detector used here, the so-called any of the configuration which was not asked but was doubled with the equipment configuration then the dot sensor which is good and detects radiation on a zero-order former target (punctiform), the so-called line sensor which detects radiation in one dimension, and the area sensor which detects radiation two-dimensional are sufficient as the configuration.
[0067] For example, in conventional X-ray CT and the conventional usual helical CT, although slit photography may be performed for dispersion line removal, since the influence of a dispersion line can be reduced even if it does not use a slit if the radiation picture signal detection equipment by this invention is applied to this X-ray CT etc., slit photography becomes unnecessary.

[Translation done.]